ADCSS10

MESA
Roundtable on
Microcontrollers for Embedded Space Applications

Introduction

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Processor for Space Applications Roadmap

Four routes/product lines were defined in the **Round Table on Next Generation Microprocessors (ESTEC on 11-13 September 2006)**:

Route A: *general purpose processor for data handling/data processing computers.*

A dedicated round table was part of ADCSS09, Next Generation Multi Purpose Microprocessor project on going.

Route B: *very high performance DSP.*

A dedicated round table on Next Generation DSP was part of ADCSS07.

Route C: *COTS processors.*

Three activities are on-going to develop COTS based Computers for space applications

Route D: m*icrocontrollers.*

in this round table we'll focus on **Route D** with dedicated presentations on requirements, possible solutions and on-going developments.

Microcontrollers in space applications

Microcontrollers are a key element in any distributed processing architecture.
They allow to implement **software based control architectures** and give a **higher flexibility** and autonomous capability versus pure hardware solutions.

Microcontrollers are the main processing unit in many applications such as:

- robotics applications
- motors control
- propulsion system control
- sensor bus control
- mechanisms control
- power control
- particle detector instruments
- radiation environment monitors
- thermal control
- antenna pointing control etc

Despite the need and importance of this element of avionics, the current **availability of a modern space qualified microcontroller is limited** as it was highlighted during the round table on Microprocessors for space application held in ADCSS 2009.

Microcontrollers in space applications

The obsolescence of the 80C32 will create a hole not filled by available high-end microcontrollers like the AT7913E.

Microcontroller applications imply a device with the following general characteristics:

– reduced component price
– low pin-count and easy to assemble package
– low power consumption
– integration of small amount of RAM
– integration of most of the I/O peripherals for control and data acquisition (serial I/Fs, GPIO's, PWM, ADC etc.)
– design emphasis on predictability rather than on the pure computing performance

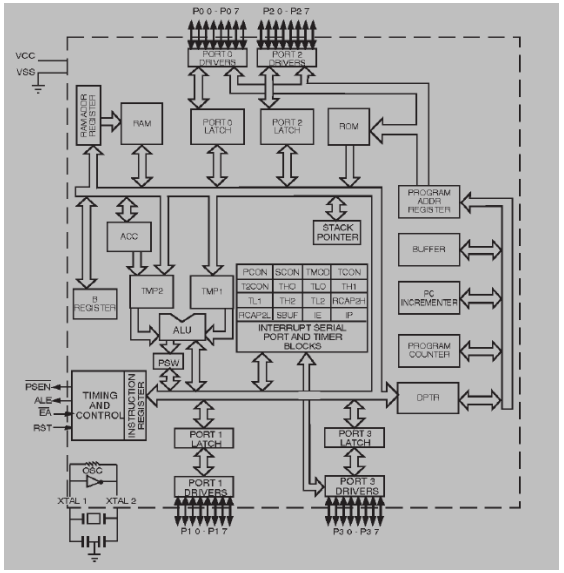
→ **Simplicity is emphasized**

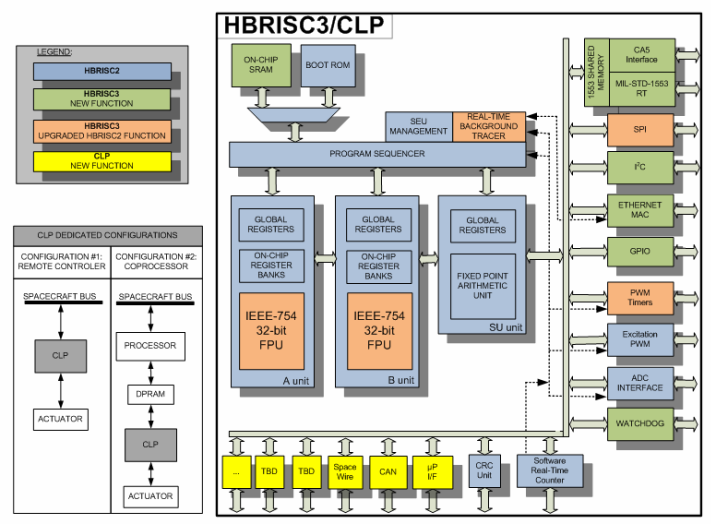
Examples of µCs for Space Applications

80C32E based microcontrollers

- ATMEL 80C32 radiation tolerant ROMless microcontroller
- 0.8µm CMOS technology, 30 Krad (Si)
- ATMEL announced end of life in 2010/11
- 44 pin package

→ See ATMEL presentation





Control Loop Processor

- Cacheless and deterministic RISC architecture with dual FPU
- Based on HBRISC processor developed by SABCA
- Used in applications characterized by complex hard real-time control loops

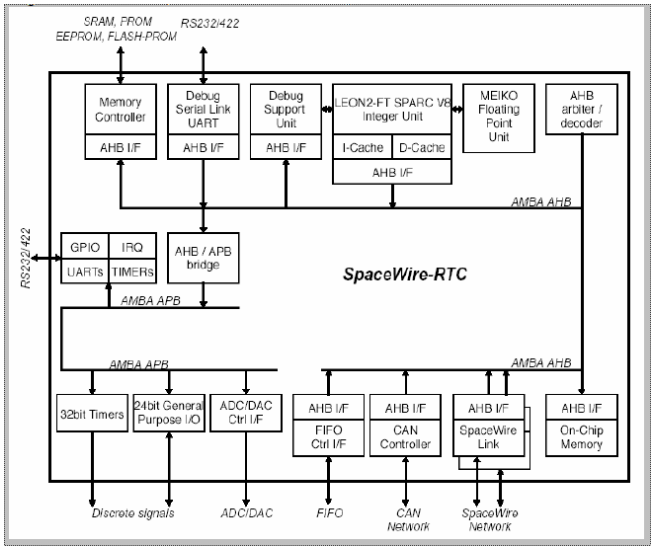
→ See SABCA presentation

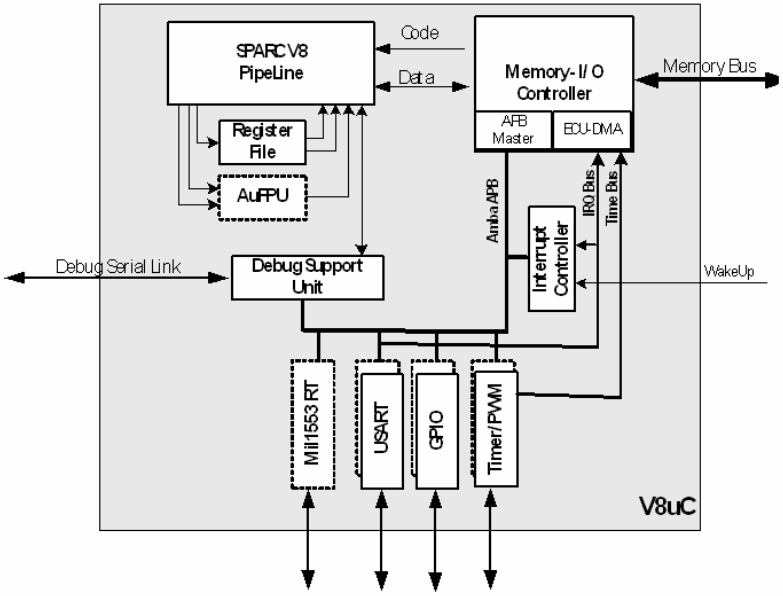
Examples of µCs for Space Applications

ATMEL AT7913E SpaceWire RT Controller

- LEON2FT SoC with cache and internal RAM
- CAN, SPW, FIFO, ADC/DAC interfaces
- MCGA package, 349 pins

→ See ATMEL presentation





V8uC Microcontroller based on LEON2 FT

- Cacheless LEON2FT IP core downsized and configurable FPU
- Memory controller with DMA engine, event controller and on-chip RAM
- It is on development as IP core

→ see SITAEL Aerospace (formerly CAEN Aurelia Aerospace) presentation

Round Table Questions

Basic Architecture

Architecture / instruction set, width of data path

a. ARM, AVR, INTEL, MIPS, SPARC, XAP …?
b. 4, 8, 16, 32, 64 bit.... ?

1. ***Floating point capability***
   a. Is IEEE compliance required, with single/double/quad accuracy, or is a reduced variant sufficient?
   b. Execution time for floating point instructions?
   c. Is SW floating point emulation sufficient?
2. ***Software methodology and tools***
   a. Programming in assembler or high level language? Which language (C, ADA,..)?
   b. Is an OS used? Which OS (RTEMS, Vxworks,…?)
   c. Debugging on a simulator or on a HW emulator with enhanced debug capability?
   d. Use of commercial or open source tool chains?
   e. Desired macro function libraries (as linker objects or on-chip in ROM)
3. ***Interrupt and sub-program handling and latency***
   a. Maximum depth of nested calls and interrupts
   b. Acceptable context-saving overhead
4. ***Memory and cache architecture***
   a. Type (RAM/ROM/volatile/non-volatile), size and width of internal and external memory?

Round Table Questions

Peripherals, mechanical & environmental

1. ***Analog peripherals***
   a. Number, type and spec of peripherals? ADC/DAC, oscillator/PLL, PWM/AWG
2. ***Digital peripherals***
   a. Interfaces to platform? Mil-std-1553, CAN, I2C, UART, MAP, PacketWire, ...
   b. Interfaces to payload? GPIO's (how many?) , SPI, ...
   c. HW accelerators for common processing tasks
3. ***Supply requirements***
   a. residual (leakage) consumption in idle mode
   b. Maximum " P / MIPS " figure
   c. Desired supply voltage(s)
4. ***Packaging options (type, pin-count)***
   a. QFP, DIL, pin-count
5. ***Environmental requirements***
   a. Temperature range, is MIL really necessary
   b. Total dose requirement
   c. Required level of SEU protection
6. ***Qualification requirements***
   a. Is QML-(V/Q) really necessary?
7. ***Other specific features***
   a. Specific DMA engines, bit/bit-fields manipulation module etc

Programme MESA

Time	Presentation
MESA - ***Microcontrollers for Embedded Space Applications***	
09:00-09:10	Introduction *Philippe Armbruster, Claudio Monteleone, ESA*
Session 1 - Microcontroller Architectures and Peripherals	
09:10-09:30	ARM Microcontrollers for Space Applications *ARM, Emre Ozer*
09:30-09:50	Using XAP processors in Space Applications *Cambridge Consultants, Chris Roberts*
09:50-10:10	Processor and Peripheral IP Cores for Microcontrollers in Embedded Space Applications *Aeroflex Gaisler, Jan Andersson*
10:10-10:30	ATMEL Microprocessors Products Family *ATMEL, Guy Mantelet*
10:30-11:00	Coffee Break
Session 2 Ongoing Microcontroller Development Projects	
11:00-11:20	Control Loop Processor - Towards European programmable solution for dedicated hard real time applications *SABCA, Marco Ruiz*
11:20-11:40	Radiation Test of 8 Bit Microcontrollers ATmega128 & AT90CAN128 *ASTRIUM Space Transportation, Sven Rakers*
11:40-12:00	V8uC: a new Sparc V8 microcontroller core derived from LEON2FT *CAEN Aurelia, Walter Errico*
12:00-12:20	Using Microcontroller & SW in Digital Control for Space Power Management Devices *ETCA, Marc Fossion*
12:20-13:30	Lunch Break
Session 3 Requirements and Driving Applications	
13:30-14:00	Microcontroller applications within Thales Alenia Space products *TAS, Livia Esposti*
14:00-14:30	Microprocessor to Microcontroller: When, Which and Why? *ASTRIUM, Timothy Pike*
14:30-15:00	Use of microcontroller for next generation platforms *CNES, Patrick Le Meur*
15:00-16:00	Round Table and Summary of the Workshop

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